Advanced Terrain Modeling and Erosion Simulation Tools to Support Training Land Management

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Presentation Overview

- Summarize the problems caused by excessive erosion on installations and highlight some of the limitations in existing erosion models.
- Present a partial solution
  - suite of erosion modeling tools applicable at multiple scales and easily implemented within existing commercial-off-the-shelf GIS.
- Present case study examples to demonstrate a few of the capabilities made available by these erosion modeling tools.

Problem

- Soil erosion is an important land management concern on military installations.
  - Impact environmental compliance and Army mission requirements
  - reduced carrying capacity
  - loss of training sustainability
  - siltation of waterways
  - runoff of contaminated sediment
  - off-site flooding
  - degradation of T&ES habitat
  - increased establishment and spread of non-native invasive weeds.

Problem

- The estimated cost of restoring damaged Army training land to tolerable levels of soil erosion is $100 - $200 million per year.
- Given the magnitude of these costs, it is paramount that more cost-effective methods of planning and implementing erosion prevention/control practices are developed.

Problem

- Limitations of existing empirical and process-based erosion modeling methods
  - don’t account for the spatial heterogeneity of land use, cover, or topographic complexity that is typical of military installations
  - don’t account for soil deposition, and therefore over-estimate soil loss
  - not fully integrated with GIS
  - all models have a limited scale of application

Solution

- Develop new and enhance existing, models to provide more accurate predictions of erosion, deposition, and sediment transport.

- Integrate these new generation models within GIS, which allow erosion, deposition, and sediment transport to be modeled while accounting for the inherent heterogeneity of landscapes (e.g., variable topography, land use, land condition, soil types, rainfall intensities, etc.).

Benefits

- These important advances will enhance the use of information on erosion and deposition potential as input for choosing optimal land-use management and rehabilitation programs.
- Example planning and monitoring applications:
  - assist land managers and trainers in optimizing training schedules
  - delineation of training areas
  - monitoring changes in land condition over time
  - maximizing the effectiveness and cost efficiency of rehabilitation or mitigation projects

Approach

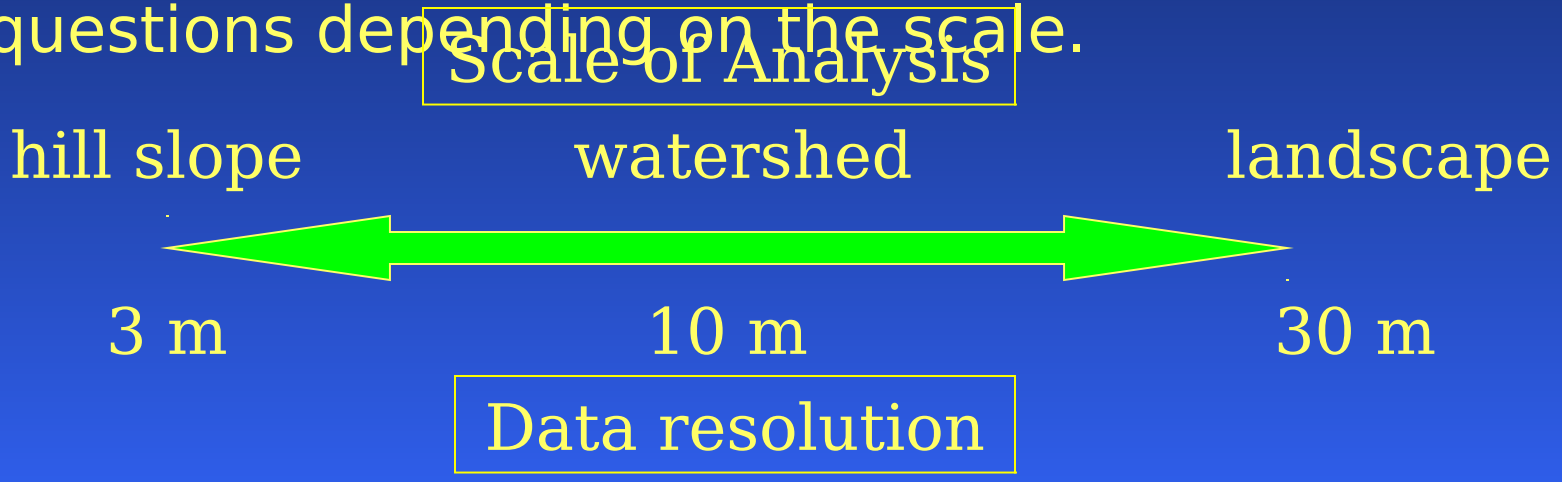
- *Develop new and enhance existing models to provide more accurate predictions of erosion, deposition, and sediment transport.*

simplified semi-empirical models for special cases → realistic, process-based, general models

RUSLE3D	USPED	SIMWE
detachment limited	transport capacity limited	event based
no deposition	no deposition	no deposition
improved LS		

Approach

- Similar to other landscape phenomenon, erosion is multi-scalar (e.g., sheet vs. rill erosion).
- Therefore is best to consider a suit of models, which can then be applied to particular questions depending on the scale.



Approach

- *Integrate new generation models within GIS.*

  Incorporated these erosion modeling tools into existing COTS and public domain GIS (e.g., GRASS, ArcInfo, & ArcView).

Approach

RUSLE 3D

- Spatially distributed hybrid model that provides long-term average soil loss values for field or watershed scale applications
- Data requirements:
  - R rainfall-runoff erosivity
  - K soil erodibility
  - **LS** up slope contributing area (DEM)
  - C vegetative cover
  - P conservation support practices

Approach

RUSLE 3D

- Limitations and Assumptions:

  Computes only gross average soil erosion from sheet, rill and inter-rill processes

  Does not estimate gully or channel erosion

  Does not estimate deposition

  Does not calculate sediment movement of estimate sediment yield

Approach

RUSLE 3D

- Applications:

  Selection of conservation practices

  Identify areas susceptible to erosion

  Compare estimated erosion to acceptable soil loss

- Complexity/Use:

  Using COTS GIS, the model can be used to generate spatially distributed output.

  Parameter values are available for most regions

Approach

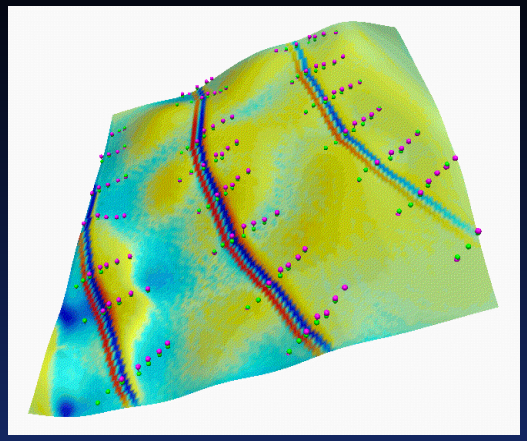
Unit Stream Power Erosion and Deposition (**USPED**) model

- Spatially distributed hybrid model that provides long-term average soil loss values for field or watershed scale applications. Estimates sediment deposition as well as soil erosion by incorporating sediment transport capacity.
- Data requirements:

  high resolution (3 -10 m) DEM

  USLE/RUSLE factors

Approach



USPED

- Limitations and Assumptions:

  Best suited for complex terrain, not uniform areas

  Highly dependent upon DEM quality and resolution

- Applications:

  Compute long-term average soil erosion and deposition

  Predict areas of high soil loss and deposition

  Conservation planning

Approach

USPED

- Complexity/Use:

  Using COTS GIS, the model can be used to generate spatially distributed output.

  USLE/RUSLE parameter values are available for most regions, but site-specific values will provide better estimates

  Performs best if DEM is smoothed using regularized spline with tension methods